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"The Perception of Trans-
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Vol 230, p. 90, No 4

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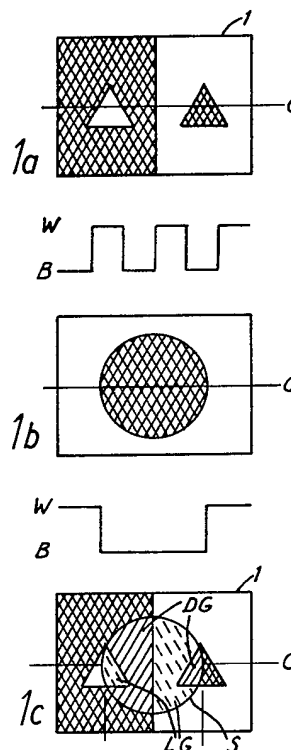
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(54) Display of visual information

(57) In order to avoid obscuring an image (e.g. Figure 1a) on for example a cathode ray tube display when a symbol (e.g. Figure 1b) is superimposed on the image, the symbol is perceptually transparent (Figure 1c).

A circuit for combining a background signal V_B and a symbol signal V_S (shown in Figure 3) operates according to the equation $V_o = V_B (1 - aV_s) + bV_s$ where $1 > a > b > 0$. The multiplier $V_B (1 - aV_s)$ diminishes the value of the background signal V_B over the area of the symbol V_S as if by the effect of perfect transparency. The added signal bV_s gives the effect of a perceivable transparency by ensuring the symbol does not disappear as the background approaches black. Contrasting edging may be added around each symbol.



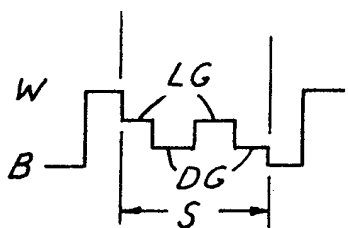
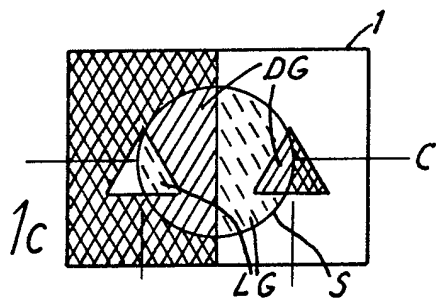
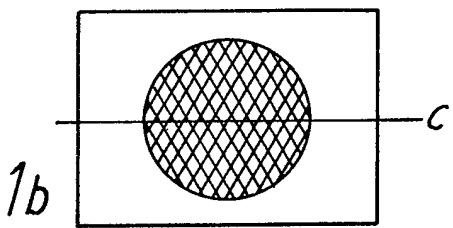
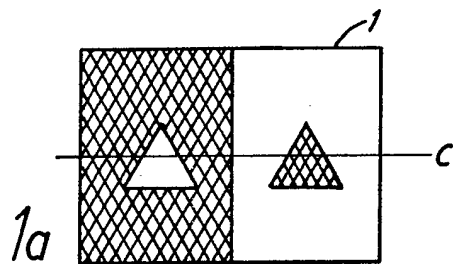


FIG. 1

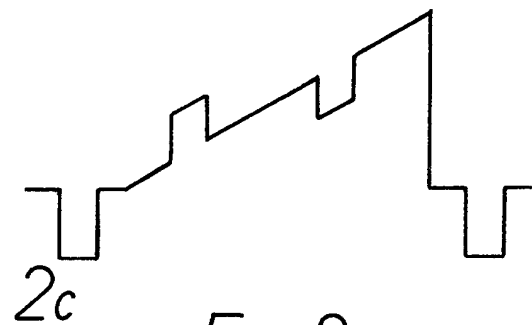
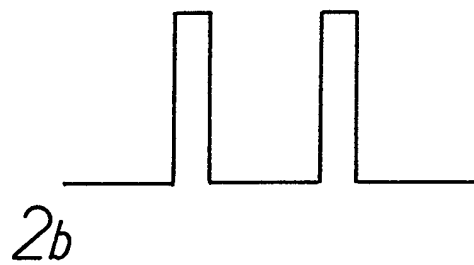
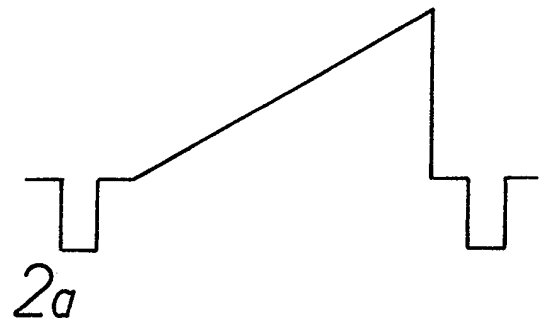


FIG. 2

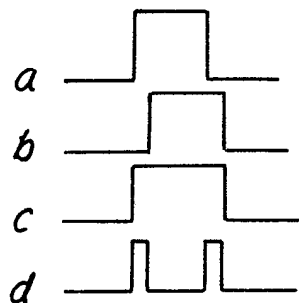


FIG. 7

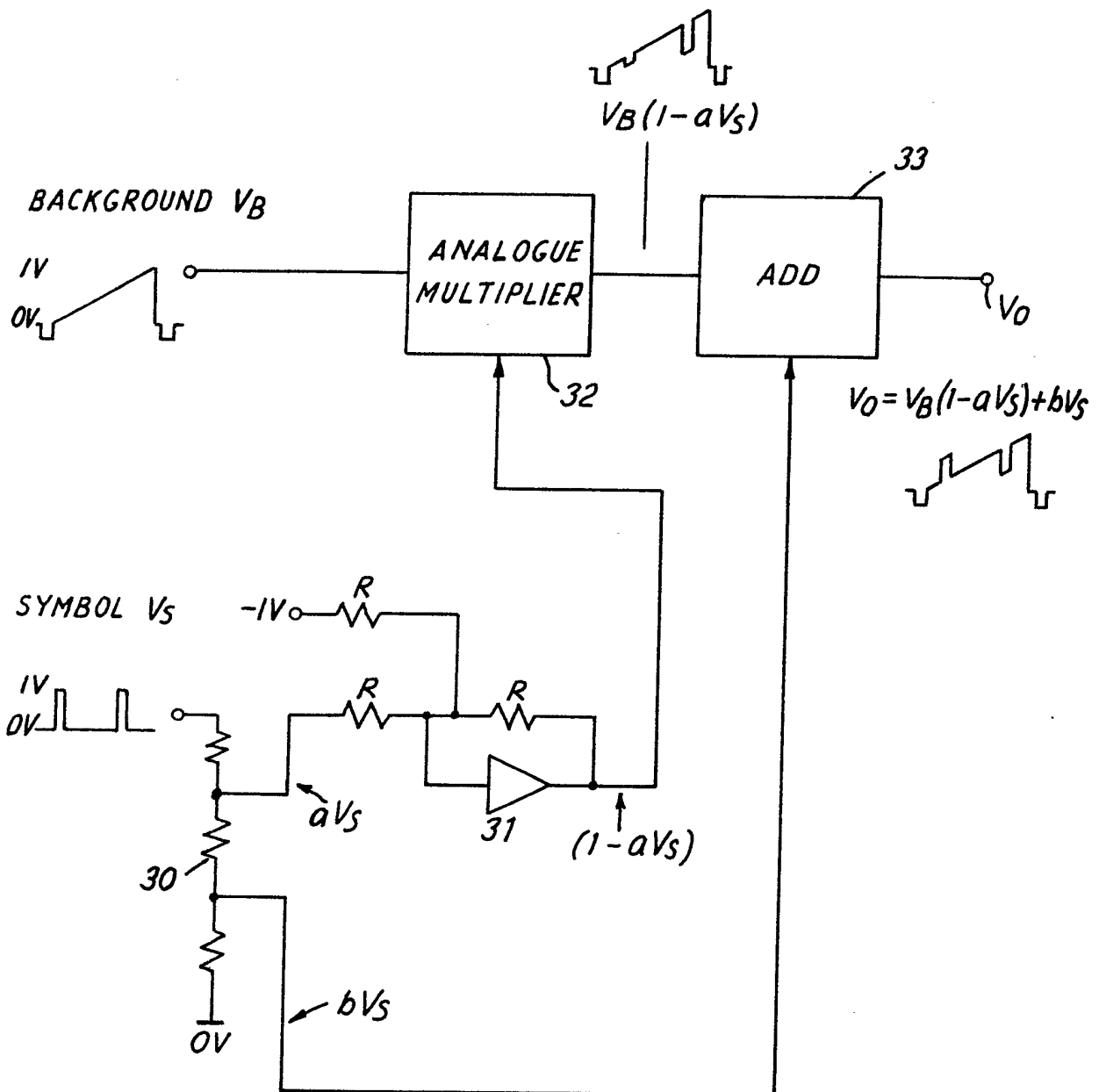
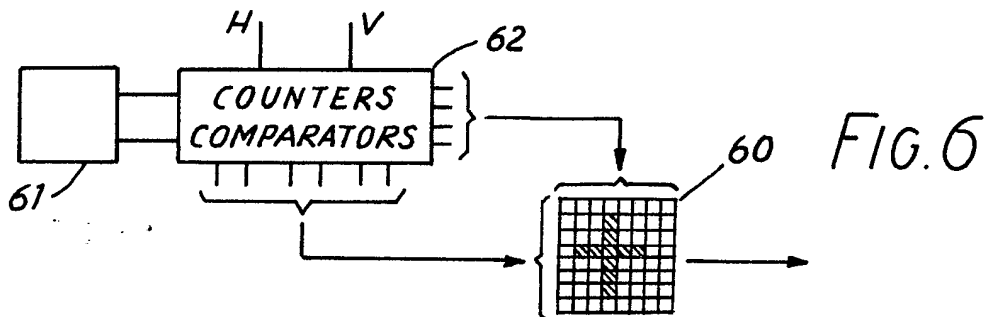
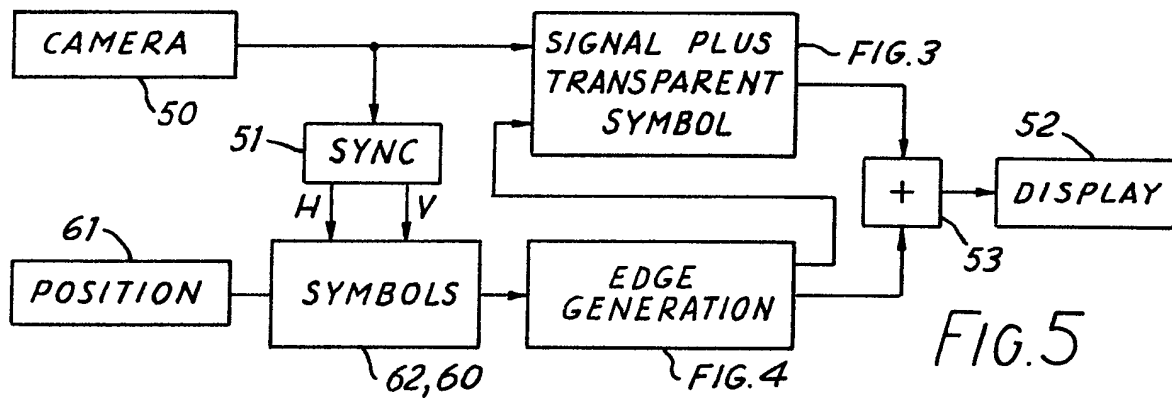
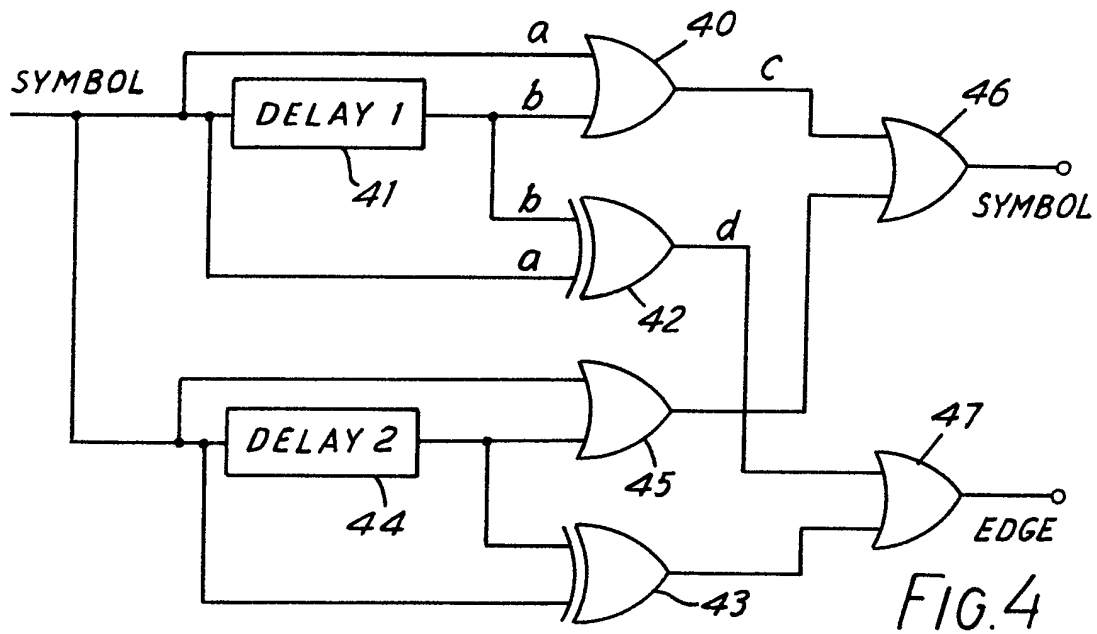


FIG. 3



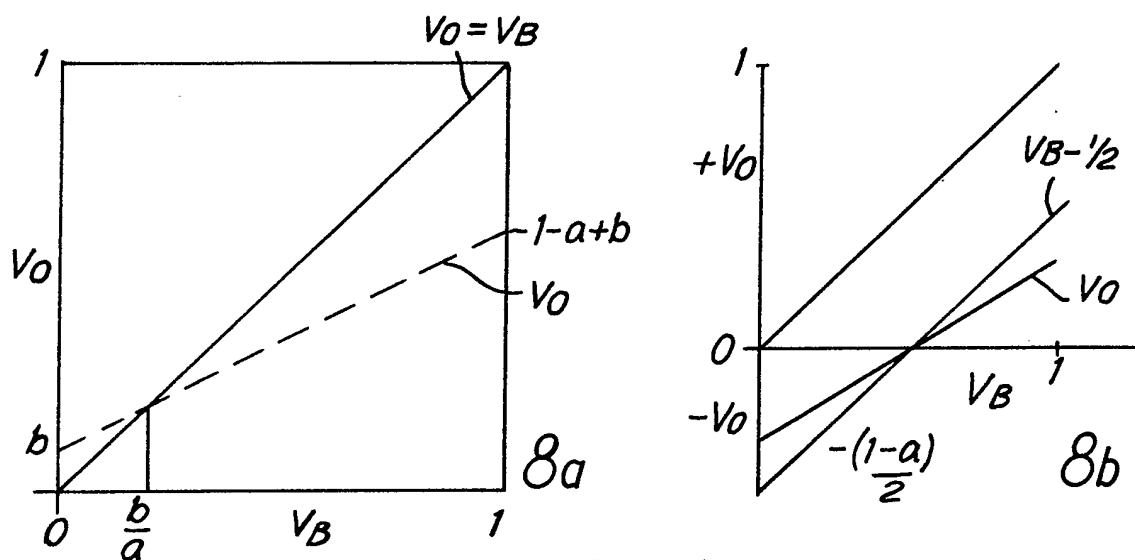


FIG. 8

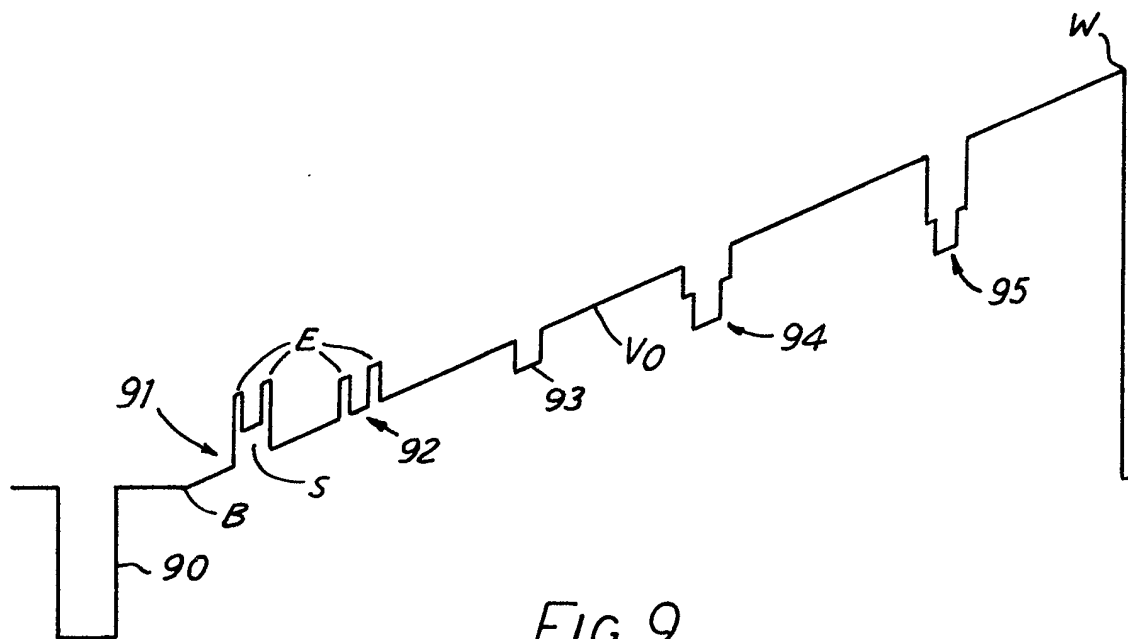


FIG. 9

SPECIFICATION

Display of visual information

5 The present invention relates to the display of visual information. 5

It is known to superimpose information over a background image on a display device. The superimposed information is commonly captions, boxes, arrows or other symbols. The known methods suppress the background over all or part of the area occupied by the superimposed information.

For example, a common method is the simple addition of either a white-going or a black-going symbol to a video signal. Unless the contrast range of the video signal is restricted to allow for the presence of the symbol, and this is usually undesirable, the symbol will have the effect of causing the white or black limits of the display to be exceeded when the background is already approaching these limits. Thus if a white-going symbol is added to a background which is near the white limit, the result will be a flat white symbol with no background detail. A similar result occurs if a black-going symbol is added to a background which is nearly black. 10 15

Other commonly used techniques suppress all background detail over the area of the symbol and replaces it with a fixed level.

The principle of the present invention is to display two pieces of superimposed information, one piece having the property of perceptual transparency.

20 Perceptual transparency is discussed in an article 'The Perception of Transparency' by Fabio Metelli in Scientific America 1974 Vol. 230(4), 90. 20

According to one aspect of the invention, there is provided a circuit for combining first and second signals representing visual information, in which the combined signals have a value greater than one of the said signals over a range of values less than a first threshold within the dynamic range of said one of the signals, and a value less than the said one of the signals over a range of values greater than a second threshold within the said dynamic range. 25

For a better understanding of the invention, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figures 1a to c are schematics explaining the principle of the invention,

30 *Figures 2a to c* show schematic waveforms explaining the invention, 30

Figure 3 is an exemplary circuit for implementing the invention,

Figure 4 shows a circuit for generating edges for symbols,

Figure 5 is a block diagram of a system utilising the invention,

Figure 6 is a diagram of a detail of *Figure 5*,

35 *Figure 7* is a waveform diagram explaining the operation of the circuit of *Figure 4*, and 35

Figure 8a explains the operation of the circuit of *Figure 3* and *Figure 8b to e* explains a modification, and

Figure 9 is a waveform diagram illustrating the operation of the circuit of *Figure 5*.

Referring to *Figure 1*, reference 1 represents a television frame, and reference C represents the central (for example) TV line. *Figure 1a* shows a background scene of a white triangle on a black background and a black triangle on a white background. Beneath *Figure 1a* is the waveform of the TV line C, B indicating black level and W white level. *Figure 1b* shows a symbol, a black circle, which is to be superimposed on the background scene of *Figure 1a*. The waveform of the TV line C is below *Figure 1b*. 40

In accordance with the invention, the symbols is superimposed on the background in such manner that it has the property of perceptual transparency. *Figure 1c* attempts to illustrate this property. (Clear illustrations of perceptual transparency are available in the article 'The Perception of Transparency' mentioned above). 45

Referring to *Figure 1c* and its associated waveform, the background (*Figure 1a*) is unaltered where there is no overlap with the symbol (*Figure 1b*). However, where the symbol exists (S in *Figure 1c*) both the symbol and background are altered. Where the symbol overlaps the white triangle and the white background there are light grey areas LG, so the white areas are darker than their originals. Where the black symbol overlaps the black background or black triangle, there are dark grey areas DG, so the black of the original background is lightened where the symbol overlaps it. 50

Figure 2 illustrates the invention in terms of waveforms. *Figure 2a* shows the waveform of a TV line of a background which varies at a constant rate from black to white as the line goes from left to right across the TV screen. *Figure 2b* shows the waveform of a symbol having two white portions space apart. *Figure 2c* shows the waveform of the perceptually transparent symbol on the background. 55

Figure 3 shows a circuit for combining a background signal V_B with a symbol signal V_S in accordance with the invention. The circuit combines the signals according to the formula

$$60 \quad V_0 = V_B (1 - aV_S) + bV_S \quad 60$$

where a and b are positive constants less than one and a is greater than b .

In *Figure 3* it is assumed that both V_B and V_S are in the range 0 to 1 volts (although they may have any other range.) 65

The circuit comprises a potential divider 30 which receives V_S and derives from two taps aV_S and bV_S . An analogue subtractor 31 forms $(1-aV_S)$ from aV_S . An analogue multiplier 32 forms $V_B (1-aV_S)$ from V_B and $(1-aV_S)$ and an analogue adder 33 sums bV_S and $V_B (1-aV_S)$ to form V_0 .

The multiplier $V_B (1-aV_S)$ diminishes the gain of the background signal V_B over the area of the symbol as if by the effect of perfect transparency. The added signal bV_S gives the effect of a perceivable transparency by ensuring that the symbol does not disappear as the background approaches black. 5

Figure 8a illustrates the relationship of V_B , V_0 , $a = 0.5$ and $b = 0.1$ for $V_S = 1$ volt. Figure 8a also shows $V_0 = V_B$ to show how V_0 varies in relation to V_B over the dynamic range 0 to 1 volt of V_B . It is apparent from Figure 8 that when $V_B = b/a$ the symbol is not visible over the background. To overcome this problem, an edging 10 may be provided on the symbol, the edge having a brightness different to the symbol so that either the symbol or the border, but not both, disappears. The edge may be white or black going, white going being preferred. 10

Figure 9 shows the effect of edging a symbol as the background varies in a uniform manner along a single TV line.

The figure shows a TV line sync pulse 90 followed by a signal V_0 derived from a background signal V_B which varies uniformly from black to white W along the line, and a symbol signal V_S according to the equation $V_0 = V_B (1 - 0.5V_S) + 0.1V_S$ where $V_S = 1$ volt. At 91, a symbol S is shown with edges E . As V_B increases, the symbol eventually disappears as at 92, but the edges E remain. At 93 only the symbol exists, whilst at 94 and 95 the symbol appears with edges. 15

A circuit for generating edges for symbols is shown in Figure 4, Figure 7 showing waveforms explaining the operation of the circuit. 20

A symbol defined by logic level '1' (Figure 7a) is applied to an OR gate 40 directly and via a first delay circuit 41 which has a delay of much less than the minimum width of a symbol to produce a delayed symbol (Figure 7b). The OR gate thus outputs a broadened symbol (Figure 7c). An exclusive OR gate 42 also receives the delayed and undelayed symbols and thus outputs edge pulses (Figure 7d) defining (vertical) edges occurring along TV lines. 25

In order to obtain (horizontal) edges in the TV field direction, the symbol is applied to a further exclusive OR gate 43 directly and via a second delay 44 of length equal to one TV line. The gate 43 will produce an output '1' only for logic '1' at one input and '0' at the other. Thus, it will output '1' only for the very first and last TV line of the symbol, when '1' is present at only one input. For other lines, '1' will be present at both inputs. 30

A further OR gate 45 receives the symbol directly and via the delay 44; the OR gate thus outputs a vertically broadened symbol. An OR gate 46 receives the output of OR gates 40 and 45 to output the symbol.

An OR gate 47 receives the outputs of the Exclusive OR gates, 42, 43 to output the edging signals.

Figure 5 shows a system utilising the invention. A camera 50, e.g. an ordinary TV camera, or an infra-red imaging device, produces video signals including horizontal and vertical sync. pulses H and V and representing 'background'. 35

The video signals are applied to a circuit for combining them with symbols to produce signals representing perceptually transparent symbols plus background, such a circuit being shown in Figure 3.

These signals are fed to a T.V. display device 52. 40

A symbol is generated for example in known manner as follows. Referring to Figure 6, a store 60, e.g. a read only memory ROM stores in its storage locations bits representing the symbol. A circuit 61, e.g. a joystick arrangement produces digital signals representing the desired position of the symbol on the display device 52. These digital signals are fed to a circuit 62 where they set comparators associated with the desired vertical and horizontal positions of the symbol in the display. Horizontal and vertical counters receive horizontal sync pulses H from a sync separator 51 (Figure 5) and when their counts equal the preset counts in the comparators, scanning of the ROM begins, feeding out the bits of the symbols TV line by TV line. The bits are fed to the edge generator circuit of Figure 4 which outputs symbols to the circuit of Figure 3 and edges to an analogue adder 53 where they are added to the output of the circuit of Figure 3 before being fed to the display device 52. 45 50

Whilst edging has been described as a way of dealing with the symbol disappearing, other techniques may be used.

One technique is to modulate the bV_S term of Equ. 1 at for example 10Hz to cause flicker.

A modification of the Equation is illustrated in Figure 8b, where the equation

$$V_0 = (V_B - \frac{1}{2}) (1 - aV_S) \text{ is illustrated.}$$

In this case V_B has a DC offset of $-\frac{1}{2}$. This is equivalent to the Equation if $b = a/2$. As voltages of V_0 less than zero cannot be displayed, the DC offset must be removed before display.

Although the invention has been described in relation to TV displays, it may be applied to any other visual displays where symbols and background are to be simultaneously displayed. 60

CLAIMS

1. A circuit which combines first and second signals representing different pieces of visual information to be displayed on a visual display device in such a manner that when the combined signal is displayed one
5 piece of information is perceived as background and the other piece is perceived to be overlying the background and be perceptually transparent. 5
2. A circuit according to claim 1, in which the combined signal has a value greater than one of the said first and second signals over a range of values less than a first threshold within the dynamic range of the said one of the signals, and a value less than the said one of the signals over a range of values greater than a
10 second threshold within the said dynamic range. 10
3. A circuit according to claim 1 or 2 wherein the signals are combined according to the formula

$$V_o = V_B (1 - aV_s) + bV_s$$
15 15
- where V_B is the signal representing the background
 V_s is the signal representing the overlying information,
and
20 a and b are positive constants less than one, a being greater than b . 20
4. A circuit according to claim 1, 2 or 3 further comprising means for storing information representing at least one symbol to be the perceptually transparent information overlying the background.
5. A circuit according to claim 4, further comprising means for generating a distinctive edging around the, or each, symbol.
- 25 6. A circuit substantially as hereinbefore described with reference to Figures 1 to 3 of the drawings. 25
7. A circuit substantially as hereinbefore described with reference to Figures 1 to 6 of the drawings.